

In re application: Hwang  
Filed: 03/28/2001  
Response Dated 05/09/2003

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Serial No.: 09/820,072  
Attorney's Docket: PAT004US  
Reply to Office action of 03/11/2003

### LISTING OF CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

#### Listing of Claims:

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1. (currently amended) A substrate comprising:  
a base substrate;  
an interfacial bonding layer disposed on the base substrate; and  
a thin film adaptive crystalline layer disposed on the interfacial bonding layer, wherein:  
the interfacial bonding layer is solid at approximately ~~room-temperature~~, 100°C and in  
acquires a liquid-like form when above room-temperature at a bonding layer melting point lower  
than the melting points of the base substrate and the thin film adaptive crystalline layer;

B1 the thin film adaptive crystalline layer has a degree of flexibility to expand or contract its  
lattice constant along a direction parallel to a surface of the substrate when the interfacial bonding  
layer is in liquid-like form; and

the base substrate is mechanically strong enough to support the interfacial bonding layer and  
the thin film adaptive crystalline layer thereon.

2. (original) The substrate of claim 1, wherein the thin film adaptive crystalline layer  
comprises approximately the same crystalline lattice structure as  $\text{In}_x(\text{Al}_y\text{Ga}_{1-y})_{1-x}\text{As}$ , wherein x is  
approximately 15% to approximately 45%.

3. (original) The substrate of claim 1, wherein the substrate comprises a substrate for  
formation of a vertical cavity surface emitting laser based on  $\text{In}_x(\text{Al}_y\text{Ga}_{1-y})_{1-x}\text{As}$ .

4. (original) The substrate of claim 3, wherein x is approximately 15% to approximately  
45%.

5. (current amended) The substrate of claim 1, wherein ~~above room-temperature comprises~~  
~~a temperature of approximately 80°C to~~ the bonding layer melting point is less than approximately

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600°C.

6. (previously amended) The substrate of claim 1, wherein the thin film adaptive crystalline layer comprises InGaAs with an In composition between approximately 15% and approximately 45%.

7. (original) The substrate of claim 1, wherein the thin film adaptive crystalline layer comprises a compound semiconductor.

8. (original) The substrate of claim 5, wherein the compound semiconductor comprises InP, GaAs, GaSb, or InAs.

9. (original) The substrate of claim 1, wherein the base substrate comprises a semiconductor, an inorganic material, a metal, or a combination thereof.

10. (original) The substrate of claim 9, wherein the semiconductor comprises GaAs, InP, GaP, Si or Ge, wherein the inorganic material comprises sapphire, poly-crystalline BN, or ceramics, and wherein the metal comprises Bi, In, Pb, Sn, Al, Ni, or metal alloy.

11. (original) The substrate of claim 1, wherein the interfacial bonding layer comprises a single layer of the same material, or multiple layers of different materials.

12. (previously amended) The substrate of claim 11, wherein the single layer of the same material or the multiple layers of different materials comprise

Bi, In, Pb, Sn, Al, or Ni; or

a metal alloy; or

inorganic materials.

13. (currently amended) The substrate of claim 1, wherein the interfacial bonding layer comprises multiple thin metal films, wherein at least some of the films ~~comprise~~ have a liquid-like

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form at a temperature above room temperature; the bonding layer melting point and some of the films remain solid at the temperature above room temperature.

14. (currently amended) The substrate of claim 13, wherein the ~~temperature above room temperature comprises a temperature of approximately 80°C to~~ bonding layer melting point is less than approximately 600°C.

B' 15. (original) The substrate of claim 1, wherein the expansion or contraction of the lattice constant accommodates material epitaxial growth.

16-34. (previously canceled)

35. (currently amended) An optoelectronic apparatus, comprising:

(a) a substrate comprising:

- (1) a base substrate;
- (2) an interfacial bonding layer disposed on the base substrate; and
- (3) a thin film adaptive crystalline layer disposed on the interfacial bonding layer,

wherein:

the interfacial bonding layer is solid at approximately ~~room temperature~~, 100°C and in acquires a liquid-like form when above room temperature at a bonding layer melting point lower than the melting points of the base substrate and the thin film adaptive crystalline layer;

the thin film adaptive crystalline layer has a degree of flexibility to expand or contract its lattice constant along a direction parallel to a surface of the substrate when the interfacial bonding layer is in liquid-like form; and

the base substrate is mechanically strong enough to support the interfacial bonding layer and the thin film adaptive crystalline layer thereon; and

(b) an optoelectronic device epitaxially grown on the thin film adaptive crystalline layer.

36. (original) The optoelectronic apparatus of claim 35, wherein the optoelectronic device is a semiconductor laser.

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37. (previously canceled)

38. (previously canceled)

39. (previously added) The substrate of claim 1, wherein the interfacial bonding layer has a finite thickness sufficient to provide the thin film adaptive crystalline layer with said degree of flexibility when the interfacial bonding layer is in liquid-like form and the interfacial bonding layer is thin enough that its surface tension will not destroy the thin film adaptive crystalline layer when the interfacial bonding layer is in liquid-like form.

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40. (previously added) The optoelectronic apparatus of claim 35, wherein the interfacial bonding layer has a finite thickness sufficient to provide the thin film adaptive crystalline layer with said degree of flexibility when the interfacial bonding layer is in liquid-like form and the interfacial bonding layer is thin enough that its surface tension will not destroy the thin film adaptive crystalline layer when the interfacial bonding layer is in liquid-like form.

41. (previously added) The optoelectronic apparatus of claim 35, wherein the thin film adaptive crystalline layer comprises approximately the same crystalline lattice structure as  $\text{In}_x(\text{Al}_y\text{Ga}_{1-y})_{1-x}\text{As}$ , wherein x is approximately 15% to approximately 45%.

42. (previously added) The optoelectronic apparatus of claim 35, wherein ~~above room temperature comprises a temperature of approximately 80°C to~~ the bonding layer melting point is less than approximately 600°C.

43. (previously added) The optoelectronic apparatus of claim 35, wherein the thin film adaptive crystalline layer comprises InGaAs with an In composition between approximately 15% and approximately 45%.

44. (previously added) The optoelectronic apparatus of claim 35, wherein the interfacial

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bonding layer comprises multiple thin metal films, wherein at least some of the films ~~comprise~~ have a liquid-like form at a temperature above room temperature, the bonding layer melting point and ~~some of the films remain solid at the temperature above room temperature.~~

45. (previously added) The optoelectronic apparatus of claim 35, wherein the expansion or contraction of the lattice constant accommodates material epitaxial growth.

46. (new) The optoelectronic apparatus of claim 35, wherein the bonding layer melting point is less than approximately 700°C.

B'  
47. (new) The optoelectronic apparatus of claim 35, wherein the bonding layer melting point is less than approximately 500°C.

48. (new) The substrate of claim 1, wherein the bonding layer melting point is less than approximately 700°C.

49. (new) The substrate of claim 1, wherein the bonding layer melting point is less than approximately 500°C.

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